Spirit Creek Watershed Monitoring Committee

Interim Report

"Credibility" (noun): capable of being believed, deserving to be believed.

This report is based on actual field sampling results carried out by/ on behalf of the Spirit Creek Watershed Monitoring Committee from September, 2000 to August, 2005.

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Spirit Creek Watershed Monitoring Committee
Working with agriculture and the rural community to ensure our environment is protected

37 Dogwood Crescent YORKTON, Saskatchewan S3N 2M6

August 2005

The Honorable Mark Wartman
Minister of Agriculture and Food
Room 302, Legislative Building
Regina SK S4S 0B3

Dear Minister Wartman:

I am pleased to present to you an interim report on the work completed by the Spirit Creek Watershed Monitoring Committee.

This committee was established to monitor water, soil and odour in response to public concerns about a multi-site hog project proposed to be developed in 2000-2001 within the Spirit Creek watershed.

This interim report covers the work of the committee from its inception in the fall of 2000 to August 2005. The committee has initiated monitoring in the three mandate areas, and the report summarizes the results and conclusions to date.

Respectfully submitted,

Don Walters
Chairman
Spirit Creek Watershed Monitoring Committee

cc: The Honorable Clay Serby

Saskatchewan Centennial 2005

106-01134/

ACKNOWLEDGEMENTS

The Spirit Creek Watershed Monitoring Committee (SCWMC) would like to acknowledge and thank all the committee members who wrote reports and worked on the various sub-committees. Their individual commitment and devotion is commendable, and without it, this project would never have succeeded. Committee members include:

1. Don Walters – Chairman of the SCWMC;
2. Don Olson – Secretary of the SCWMC, Chairman of the web site sub-committee, Chairman of the soils sub-committee (from October 2004), Mayor of the Town of Sturgis;
3. Jim Davis – Chairman of the soils sub-committee (to October 2004), cottage owner at Canora Beach;
4. Ray Riesz – Chairman of the water sub-committee, cottage owner at Good Spirit Lake, member of Friends of Good Spirit Lake;
5. Eugene Prychak – Chairman of the odour sub-committee, livestock and grain producer in the Rama area;
6. Adam Kosar – active participant on all sub-committees, Mayor of the Village of Buchanan;
7. Jack Prychak – active participant on all sub-committees, cattle producer in the Rama Area, Reeve of the R.M of Invermay #305; and
8. Florian Possberg – CEO of Big Sky Farms Inc.

The SCWMC would like to acknowledge and thank the following individuals in providing their expertise in contractual services:

1. Dr. Huiqing Guo – Assistant Professor, Department of Agriculture and Bioresource Engineering, University of Saskatchewan. Dr. Guo co-coordinated the Odour Monitoring Project and will write the required reports on the research project.
2. Mr. Keith Head – Agrologist with Head and Associates Ltd. Mr. Head coordinated the Soils Monitoring project and will write the required reports on the research project.
3. Mr. Calvin Daniels – freelance writer/ photographer with Calmardan Editorial Services.
4. Mr. Dick DeRyk – Uncommon Sense. Mr. DeRyk developed the website.
5. SIAST Woodland Campus at Prince Albert – initial website set up.

The SCWMC is a totally independent and non-bias committee appointed by Minister Clay Serby and re-appointed by Minister Mark Wartman to "direct and communicate the monitoring of intensive hog development to ensure the sustainability of the environment in the Spirit Creek Watershed" (general meeting's minutes of September 25, 2000). The SCWMC would like to acknowledge and thank the following resource staff:

1. The Honorable Clay Serby – Deputy Premier, Minister of Rural Development, MLA Yorkton;
2. The Honorable Mark Wartman – Minister of Saskatchewan Agriculture and Food (SAF);
3. Saskatchewan Agriculture and Food (SAF) - Donn Farrer, Andy Jansen, Brian Campbell, Chris Low, Darren Stovin and Bryan Gourlie;
4. Saskatchewan Watershed Authority (SWA) – Dr. Joanne Sketchell, Jim Fox and Rob Walcer;
5. Saskatchewan Environment (SE) – Joe Zarowny and Mark Getzlaf;
6. Big Sky Farms Inc. – Ernie Patrick, Manager of Field Services;
7. Sask Pork – Neil Ketilson and Harvey Wagner;
8. University of Saskatchewan – Dr. Claude Laguë and Dr. Philip Willson;
9. Mediation Services, Saskatchewan Justice – Ken Acton and John Jacques; and
10. Big Sky Farms Inc. at Rama – Duane Karcha, Feed Mill Manager and Brian Possberg, Assistant Manager, Earthen Manure Storage.

EXECUTIVE SUMMARY

We are the first committee of its kind for Intensive Livestock Monitoring in Canada and we are focusing on remaining completely 'unbiased' and to better understand the hog-related environmental issues.

Our mandate is to monitor water, soil and air. We had to have a baseline. What was out there before any pigs were in the barns or any manure spread on the land was important to know in order to properly measure any impact the barns might have.

We feel it is beneficial to have a monitoring committee to tell a true balanced story of intensive livestock development.

The Spirit Creek Watershed Monitoring Committee has been studying three key areas:

1) Air/Odour

The research project of Community Odour Monitoring using local resident observers is nearing its completion. The study has included odour monitoring by area residents, as well as specially trained nasal rangers and odour emission measurements, including seasonal and daily measurements. Compilation of data was in April 2004. The final report is still in progress and will be submitted in the fall of 2005.

The initial stage of the odour monitoring study was carried out by trained resident-odour-observers from December 2001 to November 2002. Fifty residents from 39 families were voluntarily trained as odour observers and monitored swine odours around their residences for one year. The initial data indicates more odour occurrences were detected closer to the barns, with the number declining to zero beyond a six kilometre range of the swine facilities.

Air quality sampling was also done by the Vaccine and Infectious Disease Organization (VIDO), University of Saskatchewan. The air quality results are not significantly different 600 metres downwind than 2,400 metres upwind of the barns.

2) Soils

Areas considered to be representative of soils at each of the three barn sites were sampled to establish benchmark values for nutrients in the soil prior to manure application.

In general, the soil test levels of nitrogen and phosphorus have increased in the plots that received manure applications. The other major and micronutrients have not shown significant changes.

In general, the soil test levels of nitrate nitrogen have returned to levels approximating those existing in the fall of 2001 prior to manure application. Available soil phosphorus is marginally higher than before manure application.

The minor increase and re-distribution of soil nitrate levels represents an improvement in the fertility status of the soils and does not indicate any environmental risk.

3) Water

The committee's first task was to develop a plan to establish a baseline of the water quality that existed before any liquid hog manure was applied on the land. This would include wells and dugout sites within a three-mile radius of the hog barns as well as runoff sites located throughout the watershed. It would also include the reservoirs that supply water to Rama and Buchanan. Water quality data collected at Good Spirit Lake would also be available.

We were able to begin our sampling before any manure was injected on the land, so we have a great deal of data on the quality of the surface and ground water of the area prior to the operation of the hog barns.

The runoff sampling sites were chosen for the ability to provide a clear picture of the quality of runoff water throughout the watershed. Sites were chosen upstream and downstream of the hog barns and the proposed manure application fields. Several sites would track the water quality of Spirit Creek some distance downstream.

The sampling of the runoff sites give an indication of the changing water quality as it flows through the watershed. These values may change from year to year depending on the changes in flow conditions. The amount of permanent vegetation along ditches and streams may affect the results as well. It appears at this time water quality coming from manured fields compared to commercially fertilized fields is similar.

This monitoring of water supplies has resulted in an increased awareness of the area residents to the importance of the quality of their source water and many have sought ways to protect and improve it.

General Recommendations:

- A program should be developed (by Government) that would encourage rural residents to have their well drinking water analyzed regularly at a low cost.
- To reduce the risk of surface contamination to the aquifer, land owners should be encouraged to locate and properly de-commission abandoned wells.
- To improve the quality of the water in the watershed, road and drainage ditches should be buffered to reduce the possibility of the transport of excess nutrients and other chemicals.
- It is important to maintain open communications between local communities, the public, regulators and other stakeholders.
- More research on the transmission of antibiotic-resistant pathogens from animal manure to humans needs to be undertaken, since it is an obvious public concern.
- In barns, controlling odour and dust particles at the source is an issue requiring more research.
- Improving the image of the livestock industry is a must, as more and more people are living in urban centres and know less and less about agriculture.

HOW THE COMMITTEE CAME TO BE

Don Walters

When the proposed construction of mega hog barns was announced, "Friends of Good Spirit Lake," a neutral committee, held a meeting at Good Spirit Lake. They invited both opponents and proponents of the development to give their views. Saskatchewan Agriculture and Food was asked to describe the regulation process at the meeting.

Their message was that there were six hog barns, with a total output of 120,000 market hogs to be produced per year and that the hog barn operator was waiting for RM and government approval for these hog barns to be built in the Rama and Hazel Dell area.

Three of these six barns – operated by Big Sky Farms Inc. – would be located in the basin that is part of the Upper Assiniboine River Basin, which flows into Spirit Creek and flows into Good Spirit Lake.

We were told that these barns would put an end to our beautiful lake, fish would die, the lake would be full of algae and the list of concerns and fears went on. Doom and gloom were threatened for Good Spirit Lake.

The three barns of concern were:

- **The Korchinski breeder/farrowing complex** is a 6,000 sow farrow-to-wean operation producing approximately 160,000 piglets/year. The complex consists of approximately 6,000 sows, plus boars and gilts and encompasses all aspects of breeding, gestating and farrowing sows. Annual manure production is 34 million litres (7.5 million gallons) and is stored in an engineered earthen storage facility with a capacity of 52 million litres (11.4 million gallons).
- **The Main Road nursery site** consists of four barns which take weaned piglets from the Korchinski site and raise them to approximately 29 kg, at which time they are sent off site for finishing or sold as weanlings. Total capacity of the four barns is 19,200 piglets. Annual manure production is 22 million litres (4.9 million gallons) and is stored in an engineered earthen facility with a capacity of 37.2 million litres (8.2 million gallons).
- **The Matsalla finisher** raises weanlings to market weight and is also used for in-house research. Consisting of 10 rooms with a capacity of 1,200 each, the Matsalla finisher has a total capacity of 12,000 hogs. Annual manure production is 36.8 million litres (8.1 million gallons) and is stored in an engineered earthen storage with a capacity of 54 million litres (11.9 million gallons).

After several meetings with Minister Clay Serby, he took our three options to Regina for discussion. The options were:

1. Stop the barns from being built.
2. Compost the manure.
3. Set up a monitoring committee.

In August of that same year Minister Serby appointed a 10-member monitoring committee. The Committee consisted of Don Walters as Chairperson; Jim Davis, Canora Beach; Adam Kosar, Mayor of Buchanan; Don Olson, Mayor of Sturgis; Eugene Prychak, farmer Rama area; Florian Possberg, CEO of Big Sky Farms Inc.; Jack Prychak, Reeve of Invermay and local livestock operator; Toosh McBride, cabin owner at Burgis Beach; Ray Riesz, Good Spirit cabin owner; and Randy Goulden, Tourism Yorkton. Presently we have a seven-member committee as Randy, Toosh and Jim resigned for personal reasons.

Our Committee's Mandate and Goal

As the first committee of its kind for Intensive Livestock Monitoring in Canada, we are focusing on remaining completely unbiased to better understand the hog-related environmental issues.

Our mandate is to monitor water, soil and air. We had to have a baseline. What was out there before any pigs were in the barns or any manure spread on the land was important to know in order to properly measure any impact the barns might have. We had a plan and went to work.

Air Quality – Air samples were collected at the barn, 2400 metres upwind of the barn and 600 metres downwind of the barn. The air quality results were not significantly different 600 metres downwind than 2,400 metres upwind.
Research Project: The Spirit Creek Watershed Monitoring Committee worked in conjunction with Philip Willson with the Vaccine and Infectious Disease Organization (VIDO) from the University of Saskatchewan.

Soil and Manure – Jim Davis, Don Olson and committee have worked annually with technical partners Keith Head, Big Sky Farms Inc., the public and local land owners to establish a baseline of nutrient concentrations at various soil depths. They did this to track any nutrient movement vertically and horizontally. They collected data and did comparisons at four monitoring sites and two baseline sites and compared hog manure to commercial fertilizer on four fields.
Research Project: The Spirit Creek Watershed Soil/ Manure Monitoring Committee worked in conjunction with Head and Associates Ltd.

Odour – A community odour monitoring study is underway around the three hog production sites (farrowing, nursery and finishing barn), monitoring odour exposure levels in this area regarding frequency, intensity, duration and offensiveness (FIDO). Thirty nine families were trained as odour observers. They participated in various degrees of odour monitoring from December 2001 through to November 2002.

The highest odour season was from May to July. There were two stages to this project. The first stage was December 2001 to November 2002. The second stage was March, 2003 to April, 2004. Thirty seven residents participated in this study to record odour events during their daily activities. Odour forms were supplied to them which recorded odour intensity on the 0 to 5 N-Butanol scale with 0-faint to 5-very strong. They were to record occurrence time and a general statement about the odour, as well as their own physical condition.

Two Nasal Rangers from outside the area were hired from May to October 2003. Weather information was recorded by a centrally located weather station. The nasal rangers took measurements at 120 pre-determined locations. Odour emission rates from the swine sites are measured once per month. Lagoon (EMS) sites are measured six times during the year. All data will be analyzed and reported by the end of 2005.

Research Project: The Spirit Creek Watershed Odour Monitoring Committee worked in conjunction with Huiqing Guo, Wendi Dehod, Joy Agnew and S. Pang of the Department of Agriculture and Bioresource Engineering, University of Saskatchewan and John Feddes of Agriculture and Food Science, University of Alberta.

Water Sampling – Beginning in the fall of 2000, Ray Riesz, assisted by other committee members and Chris Low of SAF, collected water samples from wells, dugouts and runoff in the Spirit Creek watershed. By the spring of 2004, sufficient data was collected to establish a baseline value and a history of seasonal fluctuations of the wells and dugouts so this monitoring could be suspended for now. Spring runoff sampling will continue throughout the watershed, both upstream and downstream of the manured fields.

This monitoring of water supplies has resulted in an increased awareness among area residents to the importance of the quality of their source water, and many have sought ways to protect and improve it. The results of runoff sampling have shown that there is little difference in the quality of water from manured fields or commercially fertilized fields.

Public Participation – We have found that, in talking to residents privately, you will get quite a different picture of what residents think than in a public meeting. We found that those going to meetings represent a more extreme position within a community, and that the community at large would most likely

not attend them. Since we wanted to understand our mandate fully, we focused our attention very strongly on the majority of residents in the community.

In talking to residents and attending community meetings, we realized each community has a mix of people, some with opposing hog barn arguments, some in favour of the development and some who don't care either way. Some of the arguments you hear are community impact, environmental or health concerns, farm structure, regulatory issues, economic factors, government involvement, legal concerns, odour worries and animal welfare.

We feel it is beneficial to have a monitoring committee to tell a true balanced story of intensive livestock development.

We understand hog barns can be an economic factor, as witnessed by the impact Big Sky Farms Inc. has had in Saskatchewan. Big Sky Farms Inc. is the largest hog producer in Saskatchewan – utilizing a three site production model. Their current portfolio of operations include:

- own and operate 44 sites in Saskatchewan and three sites in Manitoba;
- own 41,000 sows producing in excess of 950,000 pigs per year;
- own and operate 26 feed mills purchasing over eight million bushels of feed grains per year;
- own and operate two manure application systems fertilizing over 33,000 acres annually;
- employ approximately 500 people, with an annual payroll of $13 million; and
- own and operate numerous support activities including trucking, construction, maintenance, truck washes, a slat plant, research and development and a boar stud for semen collection.

In late 2005, early 2006 our committee will present our report to the public, the Saskatchewan government and its agencies and Big Sky Farms Inc.

Our Committee believes in the development of rural Saskatchewan, but it must be done in a way that protects our environment today and for the future.

Economic Development in Rural Municipalities

Although everyone has a role to play, rural residents have a greater opportunity to implement changes that will directly improve their future. Rural municipal residents have been caught in the crossfire of those who want economic development, those who do not and those who are just happy to do what they have been doing and are not interested in development of any kind.

The Spirit Creek Watershed Monitoring Committee attended RM information meetings about community intensive livestock development. We have seen those in favour of development called down and dragged down by those opposed. The issue has often left friends, neighbours and families pitted against each other. Relationships will never be the same again, and this is very sad.

Our committee feels RMs are going about this process the wrong way. RMs should know what kind of development they want and set policy accordingly, before the issue of a development project gets to the stage of such divisive debate.

We feel strongly that the RM approval process has to change to develop rural Saskatchewan. The provincial government must become more involved in facilitating the needed changes.

Committee Education

Our committee members enjoy varied backgrounds including farmers, ranchers, an RM Reeve, two town Mayors, an electrician, a Ducks Unlimited member, a potash supervisor, promotion and marketing people and many who have long term community and provincial voluntary experience.

The committee also shares a desire to learn about the needs of rural communities in developing for the present and future, while maintaining a safe and healthy environment. Decisions based on information made in concert with our stakeholders and the residents of Rama are important.

An undertaking of this type and magnitude has not previously been done in Canada, making the work of the SCWMC an important benchmark. Working with 142 residents within an eight km (five mile) radius of the three Rama hog barns is a critical part of the process. We made contact with each resident several times in our research of odour events over a three-year period. Tracking odour daily was done for 700 days.

A special thank you is extended to all Rama and area residents for their participation and valued interest in the operation of the hog barns. Some of the residents' input, we know, will help in resolving conflicts between farmers and neighbours, and help everyone come to a mutual understanding in the development of hog operations.

In addition, as part of our own education committee members attended conferences in Regina, Yorkton, Saskatoon and Winnipeg. These conferences focused on manure, manure management, nutrient management, water and water quality, manure treatment technologies, workers' and environmental regulations, land use and tours of technologies related to intensive livestock production.

At committee meetings invited speakers gave us information on what is new, what is happening in the industry at present and what is being researched in the livestock and environment area that could impact development in the future. Speakers came from: Saskatchewan Agriculture and Food; Saskatchewan Watershed Authority; Saskatchewan Environment; Alberta Agriculture, Food and Rural Development; Sask Pork; Mediation Services, Saskatchewan Justice; Head and Associates Ltd; Department of Engineering, University of Saskatchewan; Department of Agriculture and Bioresource Engineering, University of Saskatchewan; Big Sky Farms Inc.; Machibroda Engineering Ltd; Department of Soil Science, University of Saskatchewan; Vaccine and Infectious Disease Organization, University of Saskatchewan; Fisheries and Oceans Canada; and Alvin Troop, farmer, Quill Lake.

Communications

In communicating the committee's efforts and findings, meetings were held with Rama residents and interested public. As well, our newsletter, The Monitor, was distributed three times in the past four years to local area residents, with some 12,000 copies distributed each time. Newspaper advertisements, radio and television interviews, information on the SCWMC website (www.spiritcreek.ca) and one-on-one and small group gatherings were also used to disseminate information. We were in attendance or made presentations on behalf of our Committee at MacNutt, Welwyn, Moosomin, Whitewood, Foam Lake, Rose Valley, Archerwill, Rama, Swan River and Langenburg.

Full Committee Meetings*

2000	September 19 to December 31	5
2001	January 1 to December 31	10
2002	January 1 to December 31	9
2003	January 1 to December 31	7
2004	January 1 to December 31	4
2005	January 1 to August 31	5

*Does not include sub-committee meetings

REPORT ON WATER MONITORING

Ray Riesz

In keeping with our mandate to monitor the effects on the environment of the intensive hog operations in the Spirit Creek Watershed, a sub-committee was established to collect and analyze ground and surface water samples and communicate the findings to the public. Working with the SCWMC are resource and technical personnel from Saskatchewan Watershed Authority, Saskatchewan Agriculture and Food, Saskatchewan Health and Saskatchewan Environment.

The committee's first task was to develop a plan to establish a baseline of the water quality that existed before any liquid hog manure was applied on the land. This would include wells and dugout sites within a three-mile radius of the hog barns as well as runoff sites located throughout the watershed. It would also include the reservoirs that supply water to Rama and Buchanan. Water quality data collected at Good Spirit Lake would also be available.

The well and dugout sampling sites were obtained by contacting each property owner in the target area and getting a description of their water supply and usage, whether livestock or domestic or both. We also asked permission to take samples in the spring and in the fall. Most of the residents welcomed the opportunity to participate, although there was some skepticism shown by some, who wondered if we would be biased in reporting our findings. We reassured them that we were completely neutral.

The runoff sampling sites were chosen for their ability to provide a clear picture of the quality of runoff water throughout the watershed. Sites were chosen upstream and downstream of the hog barns and the proposed manure application fields. Several sites would track the water quality of Spirit Creek some distance downstream. Runoff sampling would take place only in the spring or after a severe rain event, as most sites in the upper branches of the Creek do not usually flow later in the year.

All samples collected would be "grab samples" which would indicate the quality of the water at that particular moment.

It was agreed that we have the samples collected analyzed for the major ions, water chemistry and bacteria. There are more than 30 parameters analyzed in each sample. The analysis is performed at the Provincial Health Laboratory in Regina and some duplicate analysis to verify the results were completed by the Saskatchewan Research Council in Saskatoon.

All sites were to be identified by land location, GPS readings and photographs.

What we have learned

The residents in the area rely almost entirely on the surface and ground water on their property for domestic use. Through the monitoring program many have come to realize that there is much more to water than only hydrogen and oxygen. Because a sample looks, smells and tastes good does not mean that the water is of good quality, particularly for consumption.

The majority of the wells can be classified as shallow wells – less than 15.5 metres (50 feet) deep. Some of the wells were poorly protected from contaminants. These were not properly located or sealed to prevent surface influence. Some well water contained coliforms and some had high levels of nitrate that seemed to change seasonally. A few participants have since made improvements and upgrades to their systems.

The result of the sampling program shows that each well has its own characteristics and is very dependent on the environment around it.

The dugouts as well have their own characteristics. Some are extensions of surrounding sloughs while some are isolated, depending entirely on field runoff. In times of low water supply some are refilled by pumping from another source sometimes quite a distance away.

Because of this the analytical results of the water sampling must be considered on a site-by-site basis.

The sampling of the runoff sites give an indication of the changing water quality as it flows through the watershed. These values may change from year to year depending on the changes in flow conditions. The amount of permanent vegetation along ditches and streams may affect the results as well. It appears at this time that there is very little difference in water quality coming from manured fields compared to commercially fertilized fields.

Well and Dugout Sampling – the process

We were able to begin our sampling before any manure was injected on the land, so we have a great deal of data on the quality of the surface and ground water of the area prior to the operation of the hog barns.

We began sampling wells and dugouts in the fall of 2000 with the sampling of 11 wells and 37 dugouts located in a five km (three-mile) radius of the three Big Sky hog barns in the RM of Invermay. This increased to 21 wells and 59 dugouts in the spring of 2001. In the fall of 2002 we reduced the area to be sampled to a three km (two-mile) radius. Since then there were 10 wells and 25 dugouts sampled each spring and fall. Over 400 samples were collected by the spring of 2004. After the spring 2004 collection, we believed that we had gathered sufficient data on each site to establish a baseline that future data may be referenced to.

When the results of our first sampling were received, we noticed that 25 samples contained coliform bacteria. The affected residents were phoned and reminded not to consume untreated water, as it could be harmful. Fifteen sites were then retested to verify the results. When these were analyzed, it was noted that most of the samples had improved, as the residents had taken steps to improve their supply.

Each resident participating in the program received a copy of their analyses, along with publications explaining some of the parameters as well as a copy of the Municipal Drinking Water Quality Objectives. They were encouraged to compare their results to the objectives and to contact Saskatchewan Health or Saskatchewan Watershed Authority if they have any concerns or need assistance with their water quality.

To protect the privacy of the participants, no individual's analyses were made public. Instead, the results were made available showing only the number of sites sampled and the high and low values recorded, as well as the averages for all the parameters tested.

This program was very well received, as the sampling sites increased to 25 wells and 59 dugouts, even though two residents opted to withdraw. Many calls were received from residents outside of the study area wanting to be included.

Spring Runoff Sampling

Runoff samples have been collected each spring at approximately 19 sites as near as possible to full flow conditions since the spring of 2001. These sites are located both upstream and downstream of the hog barns and the lands on which the manure is injected.

The runoff samples are analyzed for the same parameters as the dugouts. As with the dugout and well sampling, we were able to begin our sampling before any manure was injected on the land, so we have a great deal of data on the quality of the water of the area prior to the operation of the hog barns.

All but two of the sites are part of the Spirit Creek watershed. These two sites are on a watercourse that flows directly into the Whitesand River. In total, 97 runoff samples have been collected up to spring 2005.

What we have accomplished:

- Through our monitoring program, we have established a baseline to which future sampling results can be compared.
- We have communicated the results of our water sampling to the participants by supplying them with a copy of the analytical report as issued by the laboratory.
- We have communicated the results of the sampling to the general public through the use of newsletters, public meetings and our website (www.spiritcreek.ca).
- We have developed a good working relationship with the landowners and residents in the area.
- We have shown that we are unbiased and can be trusted to present the results factually.
- An added benefit to the water monitoring program was the increased awareness of the participants to the condition of their own water supply and many have taken steps to improve it.
- The Committee has become more knowledgeable of the issues concerning hog barns and water quality through attending conferences, speaking to people involved in similar monitoring projects and keeping updated on changes in the industry by inviting speakers as well as reading all information provided to us from all sources.

Where we go from here

After collecting and analyzing water samples from the wells and dugouts in the target area in the spring and fall – from the fall of 2000 to the spring of 2004 – we feel we have obtained sufficient data to establish a baseline on each site. We will not sample these wells and dugouts again for at least three years unless unforeseen circumstances warrant additional studies.

The spring runoff sampling program will continue throughout the watershed as in previous years, targeting both manured fields and commercially fertilized fields. The sampling sites extend from the barn areas downstream to Good Spirit Lake.

We will continue to inform the public of the results of our monitoring program.

Recommendations

1. A program should be developed (by Government) that would encourage rural residents to have their well drinking water analyzed regularly at a low cost.

2. To reduce surface contamination to the aquifer, landowners should be encouraged to locate and properly de-commission abandoned wells.

3. To improve the quality of the water in the watershed, road and drainage ditches should be buffered to reduce the possibility of the transport of excess nutrients and other chemicals.

REPORT ON SOIL MONITORING

Don Olson

The primary objective of the soils monitoring program is to measure and report to the general public on the possible environmental and health impacts in the Spirit Creek Watershed when liquid manure from the hog barns is injected on land as a nutrient source (fertilizer).

Much anecdotal information has been offered to justify claims of damage, but nothing specific to this area has been found.

This project will endeavor to provide factual information, which will be relevant to the type of operation (intensive livestock) and to the general area. This information should be applicable throughout Saskatchewan where intensive livestock operations (ILOs) are found or planned.

The secondary objective of the soils monitoring program is to determine whether there is any measurable difference in the soil characteristics between the use of liquid hog manure and commercial fertilizer.

The program will monitor the effect that pig manure will have on the soils when it is applied within SAF guidelines as a crop production input. The program focuses on five major areas of activity:

1. **The Initial Benchmark Program** – Areas considered to be representative of soils at each of the three barn sites will be sampled to establish benchmark values for nutrients in the soil prior to manure application.

2. **Manure/Fertilizer Comparison** – Each of the benchmark areas will be divided into two areas. One will be fertilized with commercial fertilizer and one with liquid hog manure. Crops from each will be monitored separately for yield and soil samples will be taken to establish nutrient content of each.

3. **Yearly Monitoring** – Soil samples will be taken yearly until 2005 to track nutrient movement in each of the benchmarked fields.

4. **Additional Special Benchmarks** – Samples will be taken from two additional fields in each of 2002 and 2003. These will be used for future reference if required.

5. **Reports and Data Management** – All sample sites will be GPS referenced and all data for present and future analysis will be securely stored. Annual consultant reports will be received, reviewed and acted upon as appropriate.

Responsibilities of the Soils Monitoring Sub-Committee

1. Requesting technical advice and logistic support from SAF;

2. Reviewing and confirming acceptance of the sampling project outline;

3. Participating in the selection of an Agrologist (consultant) to review and comment on the sampling program and then implement the program as directed by the committee;

4. Providing on site observation during the collection of samples and the application of manure;

5. Providing ongoing liaison with the Agrologist and other contractors required by the project;

6. Receiving and reviewing of relevant reports from the Agrologist; and

7. Distribution of information from the reports as required.

Proposed Soil/Manure Monitoring Program

The program will consist of three parts:

- A detailed program to benchmark nutrient values at each of the three sites.
- A yearly tracking of the nutrients in the benchmarked areas.
- A comparison of the effectiveness of the use of manure on the sites and a comparison to commercial fertilizer.

The benchmark areas will be used in the three-year manure application rotation. The initial benchmark program was completed in the fall of 2001.

Location of Benchmark Fields

Four quarter sections were sampled in the benchmark program. Two were near the finisher barn and one near each of the breeder and nursery barns.

Barn Field		Legal Description	Co-operator
Finisher	1	NW 6-33-6-W2nd	Lorne Matsalla
	2	SE 13-33-7-W2nd	Randy Nieckar
Breeder	3	SW 5-32-7-W2nd	Alec Dutchak
Nursery	4	SE 2-32-8-W2nd	Donald Dean

Soil Sampling Procedure

Each quarter section was divided into two areas; the smaller area will receive the commercial fertilizer and the larger area will receive the pig manure.

Three composite soil samples were collected from each field area. One sample is the composite of six individual soil samples taken from the upper slope positions in the field. The second sample is a composite of cores taken from the mid slope positions and the third is a composite from lower slope positions.

The soil cores were taken with a truck-mounted Giddings hydraulic soil sampling unit. The location of each soil core was permanently recorded using a global positioning satellite (GPS) system with differential correction to allow re-sampling at the same locations in future years.

The soil samples were taken at 30 cm (12 inch) increments to a depth of 120 cm (48 inches) in 2001 (benchmark data) prior to any manure applications. Soil sampling in 2003 and 2004, (after manure application) were done at 30 cm (12 inch) increments to a depth of 60 cm (24 inches) and in the final year of 2005 soil sampling will again be done at 30 cm (12 inch) increments to a depth of 120 cm (48 inches).

Manure/Commercial Fertilizer Comparison Program:

This comparison was not part of our mandate but it was an opportunity to determine whether hog manure was any different on the crop than commercial fertilizer.

Manure was applied to the program fields at the Breeder barn (Field 3) and at the Nursery barn (Field 4) in October of 2002. Fields 1 and 2 at the Finisher barn received manure in the spring of 2003.

The manure was injected into the soil using a three point hitch mounted applicator equipped with rolling coulters to open furrows into which the manure was injected. The manure was pumped to the applicator through a combination of pipe and flexible drag hose.

Yield measurements were conducted on the four program fields in the fall of 2003 and 2004. The grain harvested from a known area of crop was weighed to determine the yield. Yields were determined for both the Commercial Fertilizer Plot and the Manure Plot at each site.

To date, the committee's findings do not indicate any environmental risk from the application of hog manure.

Yearly Monitoring Program:

This program tracks the nutrient levels in each of the four fields in the Manure/Commercial Fertilizer Program on an annual basis. Each year after harvest, soil samples are collected from the same core sites as were used for the initial benchmark samples (2001). In the first two years (2003 and 2004), sampling was done to the 60 cm (24 inch) depth. The final sample year (2005) will be done to a depth of 120 cm (48 inches).

Based on sampling results from the 2003 report – *In general, the soil test levels of nitrogen and phosphorus have increased in the plots that received manure applications. The other major and micronutrients have not shown significant changes.*

Based on sampling results from the 2004 report – *In general, the soil test levels of nitrate nitrogen have returned to levels approximating those existing in the fall of 2001 prior to manure application. Available soil phosphorus is marginally higher than before manure application.*

Cropping is consistently reducing the soil nitrate levels in the top 60 cm (24 inches) of the soil profile. Soil samples taken in the fall of 2004 indicate that on average the nitrate has been reduced by 49 lb./ac. from the levels in the fall of 2003. This has returned the soil nitrate close to the levels existing in the fall of 2001 prior to manure application.

There has been some minor re-distribution of nitrate

within the top 60 cm (24 inches) of the soil profile. On average the nitrate levels in the 30 to 60 cm (12 to 24 inch) layer are 13 lb./ac. higher than in the fall of 2001.

According to the 2004 soils report – The minor increase and re-distribution of soil nitrate levels represents an improvement in the fertility status of the soils and does not indicate any environmental risk.

Additional Benchmark Program:

Benchmark soil samples were collected from two quarter sections in the fall of 2002.

These quarters are near the Finisher barn and are identified as:

Field 5 located in the SE 6-33-6-W2nd.
Field 6 located in the NE 1-33-7-W2nd.

Benchmark soil samples were collected from two quarter sections in the fall of 2003. One quarter is near the breeder barn and is identified as Field 7; the second is near the finisher barn and is identified as Field 8. Locations are as follows:

Field 7 located in the SE 6-32-7-W2nd.
Field 8 located in the SW12-33-7-W2nd.

Soil cores to 120 cm (48 inches) were taken with a truck mounted Giddings hydraulic soil sampling unit. The location of each soil core was permanently recorded using a global positioning satellite (GPS) system with differential correction to allow re-sampling at the same locations in the future.

Ten cores were taken from upper slope sites, 10 from mid slope sites and 10 from lower slope sites. The cores from each slope position were divided into 30 cm (12 inch) increments and combined to form composite samples.

REPORT ON ODOUR MONITORING

Committee and Huiqing Guo

The research project of Community Odour Monitoring using local resident observers is nearing its completion. The study has included odour monitoring by area residents, as well as by specially trained nasal rangers as well as odour emission measurements including seasonal and daily measurements. Compilation of data was in April 2004. The final report is still in progress and will be submitted in the fall of 2005.

The initial stage of odour monitoring study was carried out by trained resident-odour-observers from December 2001 to November 2002. Fifty residents from 39 families were voluntarily trained as odour observers and monitored swine odours around their residences for one year. The initial data indicates more odour occurrences were detected closer to the barns, with the number declining to zero beyond a six kilometre range of the swine facilities.

For the nasal rangers' odour monitoring, two trained odour sniffers – who had been specifically trained to the task of identifying odour occurrences – measured odour occurrences at 105 different locations 0.2 to 6.4 km downwind from the three production sites during the period of May to October 2003.

Swine odours were detected in 16.1 per cent of all measurements, but it should be remembered that this is in a downwind direction of the barns and includes measurements taken as close as 200 metres from the barns. Most odour occurrences (81.7 per cent) occurred in early morning (0600 to 0800h) and late afternoon (1700 to 1900h). The farthest location at which odour was detected was 6.0 km downwind from the swine site.

Detailed results will be given in the final report.

INVOLVEMENT WITH THE LOCAL RESIDENTS

Adam Kosar

My involvement with the local residents began over 30 years ago when I first started working as an electrical contractor in the area. As a result, I have become well known in the area and have earned the trust and respect of most of the local residents.

Therefore, my serving on the Spirit Creek Watershed Monitoring Committee was an asset to the committee as I know who the people are, where they live and the type of response we might expect upon our arrival.

The locals usually called if they had concerns regarding odour, soil and water contamination. They were reassured these were all being tested periodically to ensure clean air, a safe environment and a safe water supply.

Some of the residents however, did not realize how vital it was for them to fill out the odour monitoring forms. Residents had to be reminded several times that if they didn't participate by filling out these forms, then it would be presumed a problem didn't exist and therefore would not need to be corrected.

I have also had the opportunity to be present for the taking of air samples several times as well as manure injection and soil sampling. Regarding the manure injection, some residents complained of odour and run off. The odour complaint was valid but the run off was not.

I found the test strips of grain with and without the manure injection very interesting. There was a notable difference in the production of grain in the injected area. The weighing of the grain on the weigh wagon and at the elevator also confirmed the injected area was more productive.

My involvement in every area of the SCWMC has given me a good overall view and understanding of what the committee is striving to do.

In general, most of the residents were positive and were reassured their concerns were being addressed.

LARGE HOG BARN DEVELOPMENT

Jack Prychak

The Council of the Rural Municipality of Invermay was approached to approve the construction of an Intensive Livestock Operation within the Rural Municipality.

Several meetings were held with the council with representation from Big Sky Farms Inc. and local board members to discuss the possibilities of constructing a mega hog barn operation.

A special ratepayers meeting was called and a petition was presented and the majority of the ratepayers approved the establishment of the hog barns.

The Reeve of the RM decided to do a survey of approximately 20 ratepayers in the Kelvington area where the barns were in operation to get the impact the barns had on the community. From the survey there were mixed feelings, but the majority appeared to be in favour of the operation - since it has created employment, promoted grain sales and the application of fertilizer.

A group of concerned citizens met several times with the Council to disallow the development in the municipality. Since it was a small minority and all studies were completed in favour of the development Council decided to approve the construction within the RM, which began in 1999. The construction of these barns has created employment in the construction industry and supported the local community.

Now that the barns are in operation, they employ approximately 45 to 50 people. Some families have returned home from elsewhere in the province and from neighbouring provinces to be employed at the barn. Others are local residents that have found employment working at the barn.

A feed mill was also constructed in which local farmers could sell their produce. This and the construction of the barns required an upgrading of the road system within the RM Approximately 16 km (10 miles) of road were constructed with costs being shared by the provincial, federal and local governments.

Big Sky Farms Inc. pays an annual levy for the maintenance of the roads. They also assist financially to provide dust control to residences affected due to the higher volume of traffic.

Since the implementation of the hog barns in the community, employment has increased considerably, farmers have been able to sell their grain locally, many farmers have welcomed the application of fertilizers on their land and the local community has benefited.

However, the public is concerned regarding the odour from the large hog barn development. With regards to the water supply in the local area or to the Good Spirit Creek Basin, our studies have shown there has been no danger of contamination.

Personnel from Big Sky Farms Inc. have been very co-operative in all aspects. They have sponsored an annual supper to all residents of the community and have donated to many projects in the community.

WHY I BECAME A COMMITTEE MEMBER

Eugene Prychak

Odour is a major issue for the public when it comes to the establishment of a large-scale hog operation.

People living within the immediate vicinity fear that odours from the barn will impact the quality of their lifeand potentially the value of their property, because others will not be interested in purchasing land so close to a "smelly barn."

It was those concerns that led to our committee to monitor odours.

The first thing we did was to look at setting up a weather station that would be located in the area of the three barn sites.

Secondly, we hand distributed odour forms to people within an eight km (five mile) radius of each of the three barn sites. Every person in these areas could fill out when there was an odour occurrence.

In addition, as a committee we decided to have odour work shops in Rama and hand out a new type of odour forms. We wanted people to fill out these forms based on the F.I.D.O. method.

Most of the complaints that were being questioned by the public and our group had to do with odour emissions from animal production sites. In 2002, Dr. Huiqing Guo, Assistant Professor, Agriculture and Bioresource Engineering at the University of Saskatchewan, gave a presentation of what she thought she could do to test for odour coming out of hog barns and the lagoons known as EMS (earthen manure storage). In early 2003, the study started on collecting odour emissions data. This was to determine odour emission rates from hog production sources, including animal buildings and manure storage units.

During the testing events, someone from this committee was always at the sites to help observe and to help with the air collection. A total of about 20 days were spent collecting data over a period from January 2003 to March 2004.

In August 2000, I was asked by Saskatchewan Agriculture and Food if I would like to be a member of the Spirit Creek Watershed Monitoring Committee.

I accepted and on September 19, 2000 we had out first meeting, with Adam Kosar as secretary.

In August of 2004, a progress report was submitted and a final report is to be completed this summer. I personally became involved in the committee because of an interest in hog developments in my local area, which included some concerns about their impact on the lives of those in the area.

In 1997, I was involved with the Saskatchewan Wheat Pool. They were at the time looking at establishing , hog barns in the Theodore area. This group was called Yellow Head Hog Ventures. Working with this group, there were a lot of questions about the local impact the industry might have.

The things I liked was the way the group looked at finding locations in a 80 km (50 mile) radius. First when looking at locations a five km (three mile) radius from anyone's home was the minimum unless all the people in that area agreed. Over 20 locations were looked at, but only one of these was ever picked. I knew all of the good things about hog barns, but really none of the so called bad things.

In 1999, a group of individuals in the Rama area were looking for an intense livestock facility in this area. I tried asking questions about where in my area facilities would be situated, but no one would say anything until there was a public meeting in Rama.

My wife and I attended, and to our amazement there was the Invermay RM map with site locations on it. One site was one mile east of our home and another site was a mile and a half west of our home. I asked the question who picked these locations and if anyone talked to anyone living around these proposed sites? The answer was no, because the provincial guideline of 1.2 km (0.75 miles) from anyone's home was all they were concerned about. Because we were a mile away they said I should not have any concerns.

Because I asked this question at the meeting, my wife and I were immediately labeled against the project. This was the start of many more questions, as well many more people in the area were also concerned. This led to the forming of the Concerned Citizens for a Safe and Healthy Environment. Still being in opposition of this project, my questions were never fully answered because there were no different answers to possible water, soil and air pollution in this area.

When the Spirit Creek Watershed Monitoring Committee was initiated, I saw being involved as a way to help establish some of the answers I and others in the area had looked for.

I've enjoyed being on this committee from the beginning because most of the baseline data that has been collected on water, soil and air was started before or shortly after this project got in production.

My concerns are the cleanliness of these barns and the poor landscaping that was done, sometimes none. There are no trees or lawn grass, and garbage is handled and burned in small pits around the barns.

PROS AND CONS OF RAMA HOG BARNS

Darrell Dutchak

When the barns were first announced the Village Council of Rama and area residents were excited by the prospect of economic development and spin-offs for the area.

At the same time, there were concerns including possible odour problems and environmental contamination.

While the barns were being constructed, all of our businesses experienced roughly a 25 per cent increase in sales. All available housing (including the hotel) was occupied with renters. Currently, business is still about five per cent higher, on average, for our retailers than pre-barn days.

After the barns were built, we had two families move to Rama specifically to take jobs with Big Sky Farms Inc. There have been approximately 60 jobs created for new and existing area residents which were not there before.

Due to Big Sky Farms Inc. needing a reliable source of water for their operations, they purchased our old reservoir which gave the Village of Rama sufficient funds to join the Canora Rural Public Utility Board Pipeline and dramatically improved the quality of our municipal water supply.

Unfortunately, most of the people who work at the barns do not live in Rama and no new housing starts have happened as a result of their presence.

Due to odour and contamination concerns, Minister Clay Serby set up a monitoring board which is tracking odour and contamination complaints.

They are doing a very good job of watching the barns to ensure they do not begin to pose a threat to the environment. That said, we have had next to no problems with odour from the barns and the high quality cost efficient fertilizer which their operation makes available to local farmers is another boost to the local economy.

If you would like more information about the Village of Rama's relationship with the barns, please do not hesitate to contact me at 306-594-2070.

CHANGES IN AGRICULTURE

The Committee

During the last 50 years, the number of Saskatchewan farms has decreased and the size of the individual farms has increased.

There are fewer farms, fewer farmers and larger farms (80 per cent of farm land is now controlled by 20 per cent of the farmers).

The same goes for the hog sector of agriculture. The trend has been from pasture to full-time confinement, with detailed feed management of the hog's nutritional requirements. The move to confinement has also led to the development of manure lagoons and efficient waste removal which makes for a safe and healthy environment for hogs and necessitated the need for provincial agricultural operation regulations to ensure environmental safety is maintained as well.

The move to intensive livestock operations has not been without controversy, but controversy in agriculture is not unusual. From the beginning of farming, small farmers have criticized, protected and organized against creditors, courts, freight rates, markets, small guy vs. big guy, farmers vs. urban, selling, buying, big food processors, animal rights activists, environmentalists, neighbour against neighbour and on and on.

Today, the issue of intensive livestock is still, at least in-part, resistance to "little guys" versus "big farmers," only now, there is more involvement by opposing organizations on a larger scale, with powerful activist allies often involved in small community debates – especially in relation to hog barn development.

Often too, the debate is muddied by differing messages, even from the same people. What an individual will tell a researcher in private may very well not be said in public.

Understanding that change is constant in agriculture and that debate is a factor for many issues relating to farming, it is important that policy is set regarding intensive livestock operations.

APPENDIX A: DID YOU KNOW?

- the average Canadian uses 343 litres (75 Imperial gallons) of water per day (homes/gardens).
- the average pig uses 7 litres (1.5 Imperial gallons) of water each day. Note that water is not lost but is recycled directly back to the land.
- 25 mm (one inch) of rain puts 100,000 litres (22,000 Imperial gallons) of water on an acre of land.
- over 90 per cent of Canada's farms are family operated.
- manure is injected at a rate from 3000 to 12,000 Imperial gallons per acre (3,000 gallons equals 4 mm of rain over a football field).
- all mammals including people have E Coli in their manure. People can get the bacteria called E Coli-0157 H 7 from contaminated drinking water.
- the average pig produces 3.56 litres (0.8 Imperial gallons) of manure each day.
- blue water – rainfall and runoff into lakes, streams, reservoir, ground water.
- green water – the proportion of rainwater that is cycled through vegetation and soil and then returned to the atmosphere via evaporation.
- 70 per cent of the population in industrial countries lives in urban areas.
- agriculture uses 70 per cent of freshwater resources and could increase by 50 per cent in the next 34-40 years.
- Saskatchewan's land base represents 44 per cent of Canada's total farm land.
- Comparison of pig densities in the world:

Place	Pigs per acre
Saskatchewan	0.03
Iowa	0.86
China	1.32
North Carolina	1.71
Denmark	2.29

- Saskatchewan is 651,900 sq. kilometres: half of the province is covered by forest, one third is farmland, and one eighth is fresh water.
- 70 per cent of the human body is water, bones 25 per cent water.
- Each day the sun evaporates 1,000,000,000,000 (one trillion) tons of the world's total freshwater supply, 1/3 of which is underground.
- one litre of oil can contaminate up to 2 million litres of water.
- residential indoor water used in Canada:

toilet flush	15-20 litres
bath or shower (10 minutes)	100 litres
dishwasher	40 litres
dish washing, by hand	35 litres
washing hands	8 litres
brushing teeth	10 litres
outdoor water	35 litres/minute
washing machine	225 litres

APPENDIX B:

Airborne Dust, Endotoxin and DNA Downwind from Swine Barns

Jayda Cleave[1], Laura Ingram[2], Ernest Barber[3], Philip Willson[1]

Introduction

The intensive livestock industry is under continuous scrutiny in relation to potential environmental impacts and health safety issues. Adverse health affects due to dust exposure from intensive livestock facilities have received increasing attention and today are a major concern. There is reason to believe that endotoxins and microbial DNA are present in dust exhausted from swine barns. Endotoxin is a pulmonary irritant contained in the cell wall of Gram-negative bacteria that when inhaled may cause cough, phlegm, wheezing, fever and in severe cases may lead to chronic airway inflammation. In addition, a natural property of the immune system is to respond to the stimulus of microbial DNA. In order to determine the impact of barn aerosols, endotoxin and DNA concentrations must be investigated. Therefore, the objective of this study is to quantify the amount of airborne endotoxin and DNA downwind from a swine facility. It is hypothesized that increased levels of endotoxin and DNA will be detected close to the exhaust fans and that airborne endotoxin and DNA a few hundred meters away will not be different from "fresh air" upwind from the barn.

Materials and Methods

Project Sites

The project sites were Prairie Swine Centre, Elstow Research Farm Inc. and Big Sky Farms, Rama, SK. Total dust sampling for the determination of airborne endotoxin and microbial DNA commenced in April 2001 and was completed in August 2002.

Air Sampling

A total suspended solids high volume air sampler was utilized. Three samples were taken at each time point, prior to seeding, during seeding and in mid-summer to incorporate times of high and low dust loading. High volume sampling was performed at 2400m upwind ("fresh air"), 600m downwind from the barn and at an outlet (0.1m). A standard sampling time of 24 hours was used as recommended by Saskatchewan Environment and Resource Management. Total dust was determined by weighing the filters, in triplicate, before and after each sampling event. A weather station that provided continuous data on wind direction, wind speed, air temperature, and relative humidity was established by Dr. Maule to aid in the interpretation of all air samples. Three samples were excluded from analysis (and repeated) due to change in wind direction or other problems.

Post sampling, the dust was then extracted from the filter with sterile nonpyrogenic water during incubation in a sonicator. The extract was analyzed for endotoxin, using a *Limulus* Amebocyte Lysate test kit, and DNA, using standard UV absorbance techniques.

Statistical Method

A Kruskal-Wallis one-way analysis of variance was used to compare the data. A value of $P<0.05$ was considered statistically significant.

[1] Vaccine and Infectious Disease Organization, University of Saskatchewan
[2] Department of Agricultural and Bioresource Engineering, University of Saskatchewan
[3] Dean, College of Agriculture, University of Saskatchewan

Results and Discussion

Total dust (Figure 1; P=0.001) and endotoxin (Figure 2; P=0.001) concentrations declined significantly at a distance from the barns. Comparison of mean ranks indicated that at both study sites there was no significant difference between the dust and endotoxin concentrations 600m downwind compared to 2400m upwind, but the concentrations at the outlet were significantly higher than the upwind and downwind locations. Location did not have a significant effect on the DNA concentrations (P=0.0733; Figure 3) around the swine barns. Season did not have a statistical impact on total dust (P=0.3496), endotoxin (P=0.3982) or DNA (P=0.8117) concentrations downwind from swine barns.

The results support the hypothesis that the concentration of total dust and endotoxin 600m downwind from the barns is not statistically different from the "fresh air" upwind from the barn. However, neither distance from the barn nor season had a statistical impact on DNA. Microorganisms are ubiquitous, therefore more detailed research is required to attribute the endotoxin and DNA found in the air downwind from the barns to the swine operation. The data shows that contaminants expelled from the two Saskatchewan swine barns, are diluted to that of background levels 600m downwind from the barn. It may be suggested that airborne contaminants downwind from swine operations are not necessarily a direct result of the swine facility itself, especially in agriculturally active areas. In addition, many environmental factors may have an impact on the distribution of the airborne contaminants. For the purposes of this study it was assumed that the activity within the barn was consistent and would not have an impact on the output of contaminants from the barn, however the activities within the barn could in fact have an impact on the types of contaminants and the amount of contaminants exiting the barn.

Implications

There appears to be modest environmental concern downwind from barns, which may be managed with controls such as landscaping. These results are applicable to modern confinement livestock operations that interact with neighbours or the general public.

Acknowledgments

Support for this work was provided by the Canadian Institutes of Health Research fellowship for Public Health and the Agricultural Rural Ecosystem, Canadian Pork Producers Livestock Environmental Initiative, Saskatchewan Agriculture and Food Development Fund, Big Sky Farms Inc., Spirit Creek Watershed Monitoring Committee, Sask Pork, Alberta Pork, Manitoba Pork.

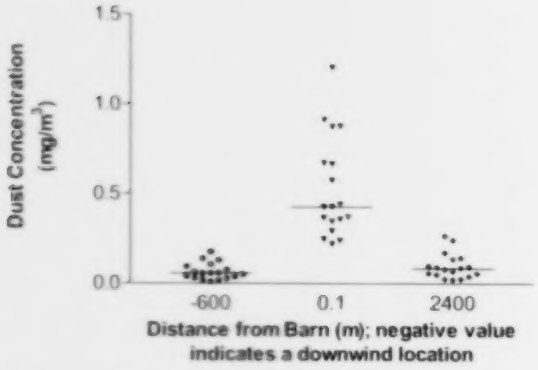


Figure 1. Total dust concentration (mg/m^3) upwind 2400m, at the outlet (0.1m) and 600m downwind from the barns.

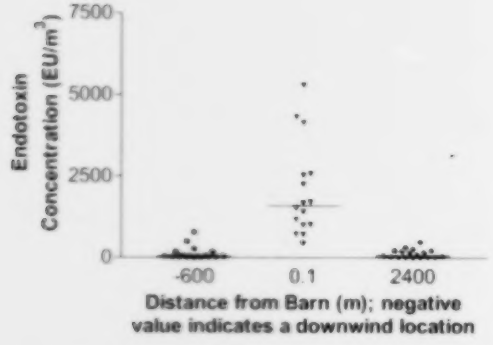


Figure 2. Endotoxin concentrations (EU/m^3) upwind 2400m, at the outlet (0.1m) and 600m downwind from the barns.

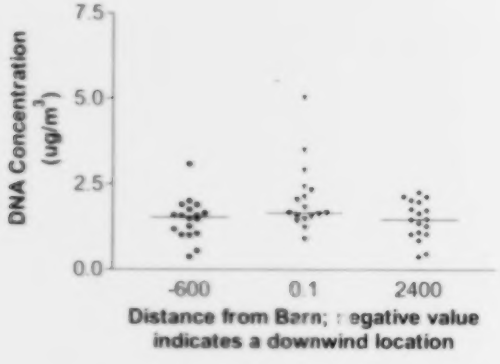
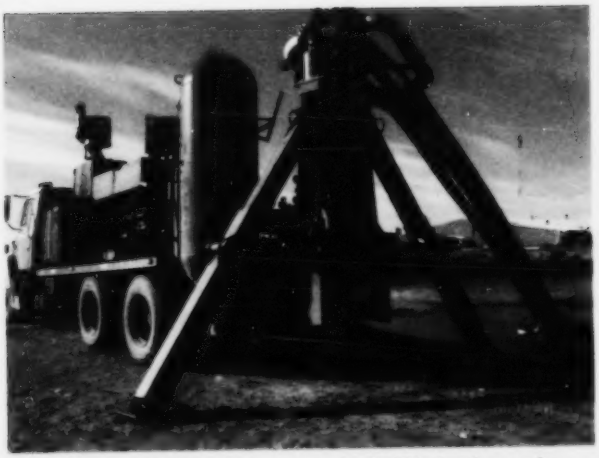


Figure 3. DNA concentrations (µg/m^3) upwind 2400m, at the outlet (0.1m) and 600m downwind from the barns.

APPENDIX C:

Local community well.



Main manure delivery pump to the field injection unit.

Typical runoff sampling site at discharge end of culvert.

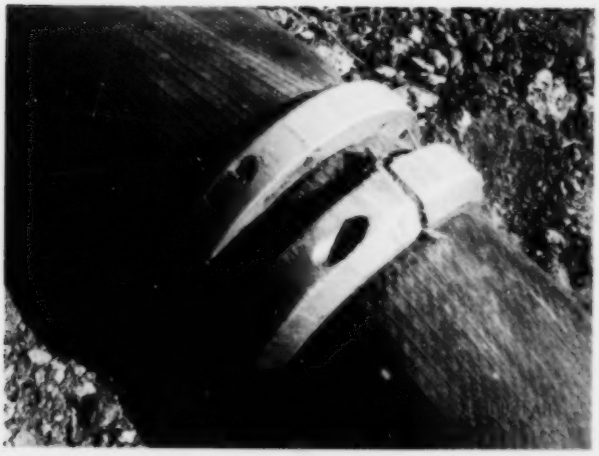
Manure injector showing distribution manifold and trailing deliver hose.

Agitator pump at earthen manure storage.

Coulter-type liquid manure injector.

Moving the flexible manure hose supplying the field injection unit.

Typical field appearance after manure injection.

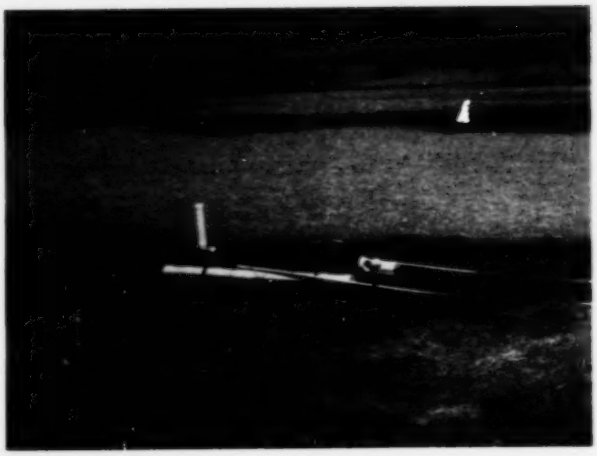


Coupler on flexible manure hose.

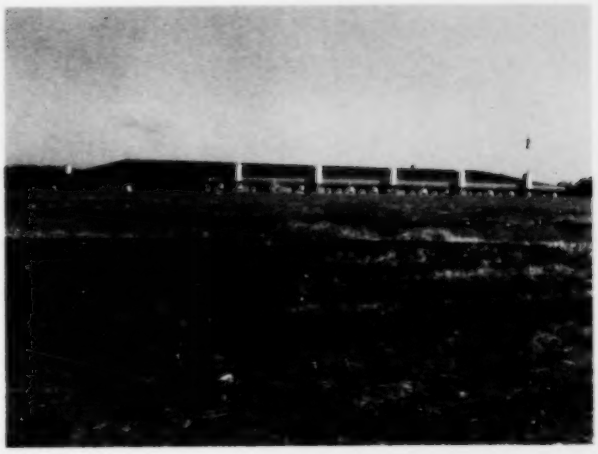
Sample collection to 120 cm (48 in.) deep with a Giddings hydraulic soil sampling unit.

Headland on manured field.

Continuous air sampling from an exhaust fan using a peristaltic pump.



Odour collection from an earthen manure storage.



Hog finishing barn.

Straw covered earthen manure storage.

Yield testing between commercial fertilizer and liquid hog manure.

SPIRIT CREEK WATERSHED MONITORING COMMITTEE

RESEARCH PROJECT

PRAIRIE MAPPING SERVICES
Box 75, Theodore SK S0A 4C0
Phone/ Fax (306) 647-2360
Website www.prairiemapping.com
Specializing in G.I.S. Mapping Applications

SCALES
0 1 2 3 4 5
KILOMETERS
0 1 2 3
MILES

Drawn by: Bruce Fredericksen September 26, 2003

RM of Invermay #305 | RM of Buchanan #304

RG 8 | RG 7 | RG 6

TP 33 | TP 32 | TP 31

STONEWALL LAKE

LEGEND

- Highway
- All Weather Road (Winter Plowed Roads)
- Summer Road (Seasonal)
- Bridge
- Waste Disposal Site
- Historical Site
- Railway
- Chem. Can Disposal Site
- Town Lagoon
- Gravel Pit
- Occupied Residence
- Church
- School
- Cemetery
- Lake/Slough
- River/Creek
- Community Well
- Hamlet
- City, Town, Village
- Grain Terminal
- Marsh
- Dugout
- Nursery Barn
- Farrowing Barn
- Feeder Barn
- Feed Mill

PROJECTS

- Soil & Manure Monitoring Site

WATER PROJECTS

- Runoff Monitoring Site
- Well Monitoring Site (3mi)
- Well Monitoring Site (2 mi)
- Dugout Monitoring Site (3mi)
- Dugout Monitoring Site (2mi)

ODOUR PROJECT

- 5 Mile Radius (N.T.S.)

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SPIRIT CREEK WATERSHED MONITORING COMMITTEE

RESEARCH PROJECT

PRAIRIE MAPPING SERVICES
Box 75, Theodore SK S0A 4C0
Phone/ Fax (306) 647-2350
Website www.prairiemapping.com

SCALES

KILOMETERS 0 1 2 3 4 5

MILES 0 1 2 3

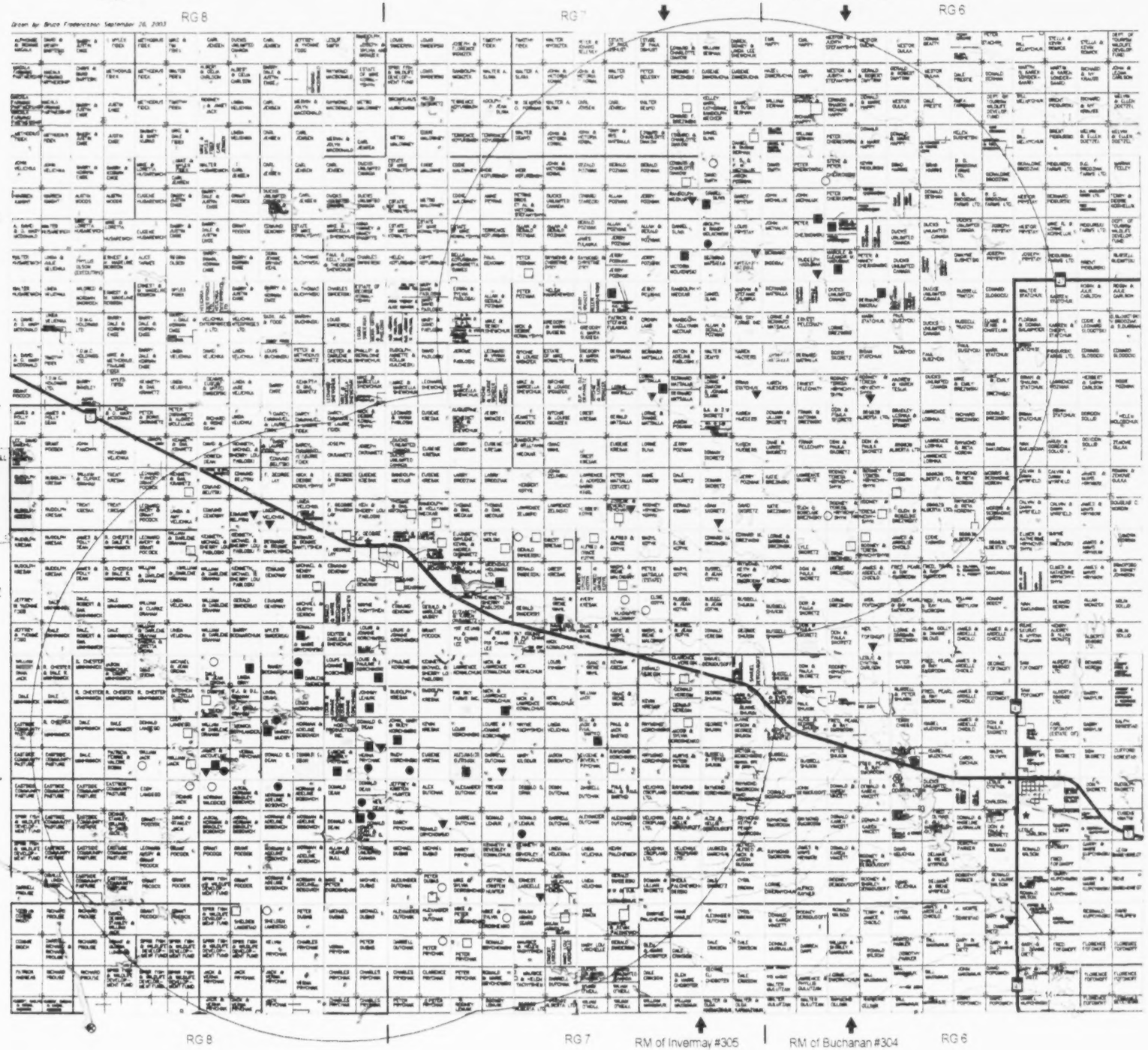
Drawn by: Bruce Fredericton September 26, 2003

RM of Invermay #305 | RM of Buchanan #304

RG 8 | RG 7 | RG 6

TP 33 | TP 32 | TP 31

STONEWALL LAKE



LEGEND

- Highway
- All Weather Road (Winter Plowed Roads)
- Summer Road (Seasonal)
- Bridge
- Waste Disposal Site
- Historical Site
- Railway
- Chem. Can Disposal Site
- Town Lagoon
- Gravel Pit
- Occupied Residence
- Church
- School
- Cemetery
- Lake/Slough
- River/Creek
- Community Well
- Hamlet
- City, Town, Village
- Grain Terminal
- Marsh
- Dugout
- Nursery Barn
- Farrowing Barn
- Feeder Barn
- Feed Mill

PROJECTS

- Soil & Manure Monitoring Site

WATER PROJECTS

- Runoff Monitoring Site
- Well Monitoring Site (3mi)
- Well Monitoring Site (2 mi)
- Dugout Monitoring Site (3mi)
- Dugout Monitoring Site (2mi)

ODOUR PROJECT

- 5 Mile Radius (N.T.S.)

Summary Of The Odour Research Project

By Huiqing Guo

Dept. of Agricultural and Bioresource Engineering, University of Saskatchewan, SK

The objectives of this study were to monitor the odour exposure levels of residents living in the vicinity of swine production operations. A rural area in eastern Saskatchewan was selected for this study. This area had a three-site 5,000 sow farrowing-to-finishing swine operation with a flat topography and a total of 147 residences within 8 km radius of the three sites. There were two stages for this project. Stage I was a preliminary odour monitoring conducted by local residents from December 2001 to November 2002. Stage II was conducted from May 2003 to April 2004 which including a) odour occurrence monitoring by trained residents using modified method, b) odour occurrence monitoring using two hired odour assessors, and c) seasonal and diurnal odour emission measurement from the three swine sites.

Stage I: Odour Occurrence Monitoring by Trained Resident Observers

Fifty residents from 39 families were trained as odour observers to use a 5-point n-butanol intensity reference scale to rate intensities of swine odours detected around their residences for one year.

a) Swine odours were detected by observers from 23 families living 1.6 km to 6.0 km from the swine farms. Eleven families 2.3 to 6.0 km and five families 6.0 to 8.6 km away from the swine farms did not detect swine odours.
b) Most swine odours (70.3%) were detected during the warm season from May to October. Manure land application contributed to high odour occurrences in May, June and October. The majority of odours (54.6%) were detected during 1700 to 0900h from the late afternoon throughout the night until the early morning.
c) Annual odour detection frequencies for twenty families ranged from 0.01% to 0.80%. Three families had higher odour occurrence frequencies of 1.19% (5.9 km), 1.51% (5.4 km), and 3.32% (2.8 km, near two other livestock farms).
d) Odours with intensity 3 or above were reported the most (82.2%) while very few low intensity odour events were reported. Odours with intensity 5 were reported throughout the year regardless of the season. Odour intensity might have been overestimated by some observers. Similarly, odours with offensiveness 3 or above made up 77.0% of all odours.
e) No correlation was found between the detection distance and number of odour events.
f) Using resident odour observers for long term and long distance odour dispersion measurement has proven to be practical and effective. However, improvement of this method is needed ensure the quality of the data. The possible options include implementing periodic nose calibration, screening the observers for bias for or against the intensive livestock operations, and taking measurements at designated times.

Stage II: Odour Occurrence Monitoring by Trained Resident Observers

Thirty-two resident-odour observers from 28 families (four families had two observers in one family) participated in Stage II of the study during May 2003 to April 2004. They were also trained to use the 5-point n-butanol intensity reference scale to rate intensities of swine odours detected around their residences. They were provided with a set of the intensity reference scale and asked to calibrate their nose at least once a week. They were also asked to measure odours at least twice a day, once in the morning and once in the evening and record any swine odour they

detected during their daily activities. The three swine production sites and manure applications were probable sources for a total of 638 odour events.

(a) Swine odour was detected up to 6 km downwind. Swine odours were also reported up to 7.6 km from the swine sites although this rarely happened (a total of 21 odours reported by 4 families living 6.0 to 7.6 km away from swine sites in a year), but whether these odours were swine odours and whether they were originated from other nearby livestock sources needs to be further validated.
(b) Sixteen families recorded detailed durations of the odour events while the information from the other families was insufficient to calculate the annual odour detection frequency. Annual odour detection frequencies for 15 families ranged from 0.01% to 1.60%. One family had the highest odour detection frequencies of 3.00% (2.7 km from the finishing site).
(c) The highest odour season was from May to October during May 2003 to April 2004. 52.1% of annual odours and 57.0% of May-to-October odours were detected during the early morning, evening and night.
(d) Of all swine odours, 44.3% were intensity 1 or 2 odours while 28.1% were intensity 3 odours, the other 27.5% were intensity 4 or 5 odours. This was very different as compared to the Stage I results, where intensities 1 and 2 odours were reported 3.3% and 13.3% of all odours but intensities 4 and 5 odours made up over 50% of all odours. This result indicates that periodical nose calibration was needed to ensure the quality of intensity rating.
(e) Of all swine odours, 43.8% were assigned offensiveness 1 (not annoying) or 2 (somewhat annoying) and 27.5% as offensiveness 4 (very annoying) or 5 (extremely annoying).
(f) As rated by the observers, 77.2% of intensity 2 odours were considered as not annoying or somewhat annoying regarding offensiveness.
(g) Odour intensity might have been over rated for intensity by some odour observers due to the individual's perception and sensitivity to swine odours.

Stage II: Downwind Odour Occurrence Monitoring by Trained Odour Assessors (Nasal Rangers)

Two trained odour assessors monitored odour occurrences at 105 different locations 0.2 to 6.4 km downwind from the three production sites during the period of May to October 2003. Most measurements (81.7%) were taken in the early morning (0600 to 0800h), evening (1700 to 1900h), and some afternoons. Based on the downwind odour measurements conducted by the two trained odour assessors over the six months of warm season, the following conclusions can be drawn:

(a) Swine odours were detected in 16.1% of all downwind measurements on 105 locations, which resulted in a total of 921 swine odour events. The farthest detected location was 6.0 km from the closest swine site. Five locations were never detected of any odour, including the farthest location (6.4 km) from the swine site.
(b) October and May had the highest odour detection frequency of 25.7% and 24.0%, which might be caused by frequent manure land applications. September had the lowest detection frequency of 8.5%.
(c) Intensity 1 and 2 odours (very faint and faint) were reported the most (61.4%). Intensity 4 and 5 odours (strong and very strong) were reported the least (19.0%); that occurred most frequently in June and October but the least in July and August.
(d) As for odour offensiveness, 64.3% of all odour events were reported as 'not annoying' or 'somewhat annoying' (offensiveness 1 or 2) while 16.6% were reported as 'very annoying' or 'extremely annoying' (offensiveness 4 or 5). A linear relationship existed between intensity and offensiveness ($r^2 = 0.83^{**}$). All odours with intensity 1 and 89.7% of odours with

intensity 2 were considered not annoying or somewhat annoying by the assessors. This again may shed light on setting acceptable odour intensity criterion. Considering all the odour measurement by the resident observers and the hired odour assessors, odour intensity 2 may serve as odour annoyance free level in rural area around livestock operations.

(e) Regarding diurnal odour occurrence, most measurements (81.7%) were taken during the hours of 0600 to 0800h and 1700 to 1900h and the odour detection frequencies were 13.7% to 20.2%, respectively. Odour detection frequency was the highest between 0800 and 1000h (21.8% to 30.8%). Intensity 4 and 5 odours occurred during most of the measured time periods.

(f) The odour detection frequency at a receptor's location had a weak linear relationship with the distance from the odour source. The average detection frequency per location was the highest within 0.5 km (40.3%) and the lowest at a distance of 4.5 to 5.0 km (6.3%). Beyond 1 km, the higher the odour intensity, the lower its detection frequency was. Odours with all intensities were observed within 6 km except no intensity 5 odour was observed beyond 4.0 km from the source.

For all the three sets of data obtained by the resident odour observers and hired odour assessors, the impact of weather condition, wind speed and atmospheric stability class, was quite similar:

a) The number of odour events had an inverse linear relationship with the wind speed; the lower the wind speed, the more odour events were reported. Most odour events were detected when the wind speed was equal or less than 5 m/s. Odours with high intensities were detected at various wind speeds up to 9.4 m/s and at a distance of up to 5.8 km from the swine farms.

b) Most odour events were detected under atmospheric stability class (SC) D (61.0 to 62.9%) with windy or overcastting weather conditions. Stable weather SC E to G occurred mostly at night when observers were likely not outside to conduct measurement. Odours with various intensities were observed under various stability classes except SC A, suggesting that stability class may have limited effect on odour dispersion within the measurement distance (<8 km), which may be different than long distance air contaminant transportation. Rather, wind direction and wind speed are determining factors for odour dispersion. The result of this study indicated that the air dispersion models may not be applicable for odour dispersion within short distance.

The results of this study suggests that odour occurrences, as experienced by the resident odour observers, varied with season, time of a day, location including distance and direction from the swine farms, weather conditions (wind speed and direction), presence of the observers outside of their residences including seasonal and diurnal lifestyles and routines, and olfactory sensitivity of the residents. All these factors need to be considered when setting odour criteria for communities in the areas located near intensive swine operations.

During the warm season of May to October, the finishing barn had the highest odour emission rate, followed by the nursery, farrowing, and gestation barns. The odour emissions from the farrowing EMS were lower than those from the farrowing barns (which included the farrowing and gestation barns) by 21%; however, the odour emissions from the nursery and finishing barns were lower than those from the nursery and finishing EMSs by 95% and 22%, respectively. This indicated that a) during the warm season, barns and the EMSs were all major odour sources, b) straw covers on the EMSs were effective to reduce odour emissions. Without straw covers, the EMSs would be much greater odour sources than the barns. Comparing the three sites, the finishing site had the highest odour emission rate; the emission rates of the nursery and farrowing sites were 56.2% and 39.2% of the finishing site emission rate, respectively.